

Offshore Wind in North Carolina

Advisory Subcommittee – Offshore Energy Exploration
April 27, 2009

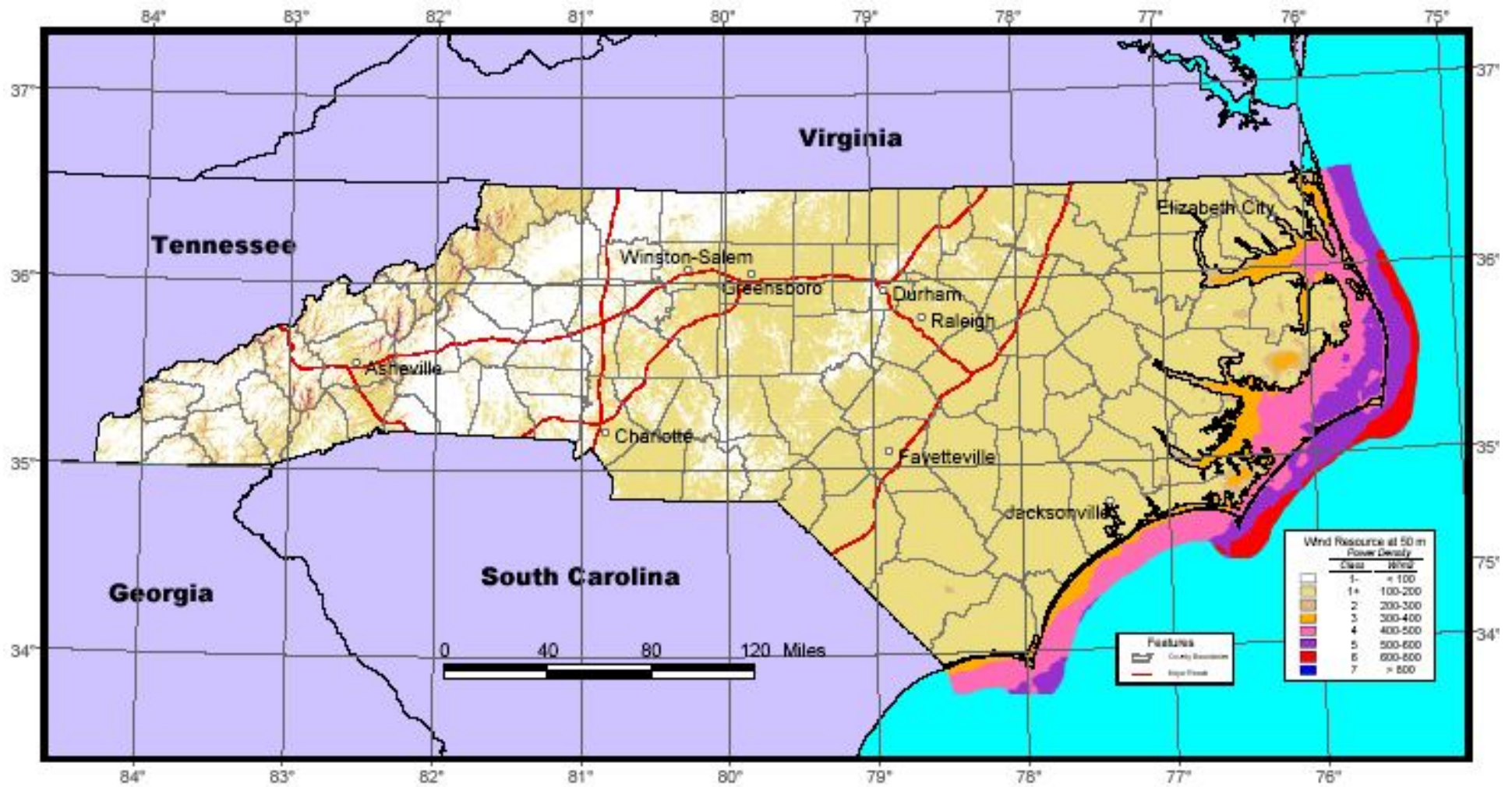


Bob Leker
Renewables Program Manager
State Energy Office

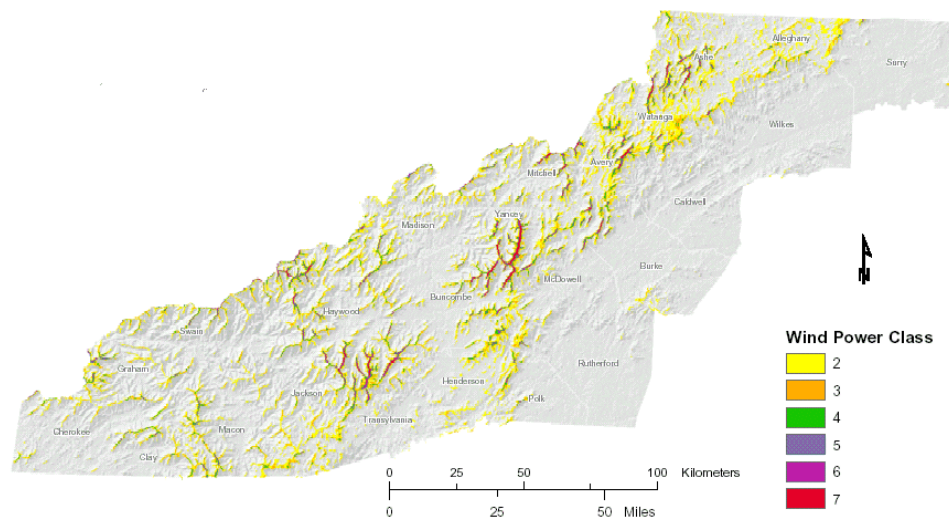
Overview

- ▶ North Carolina Wind Resource
- ▶ International Examples
- ▶ Opportunities & Issues

North Carolina Wind Resources



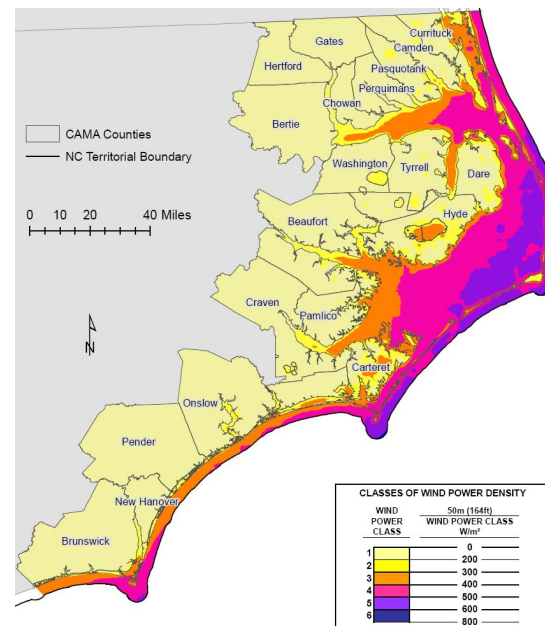
Mountain and Coastal Region Opportunities- to reach 2400 MW



Western NC Wind

970 MW on 93 miles of ridge from 647, 1.5MW turbines

(Conservative estimate based on developing 5% of the developable ridge over 3,000 ft. with strictest exclusionary zones, and transmission access considerations)



Eastern NC Wind

1,430 MW wind capacity on-shore and in sound waters from 2 and 3MW turbines over 26.5 square miles. (Atlantic Ocean siting not considered)

Transmission bottlenecks heading west may be the largest restriction of capacity.

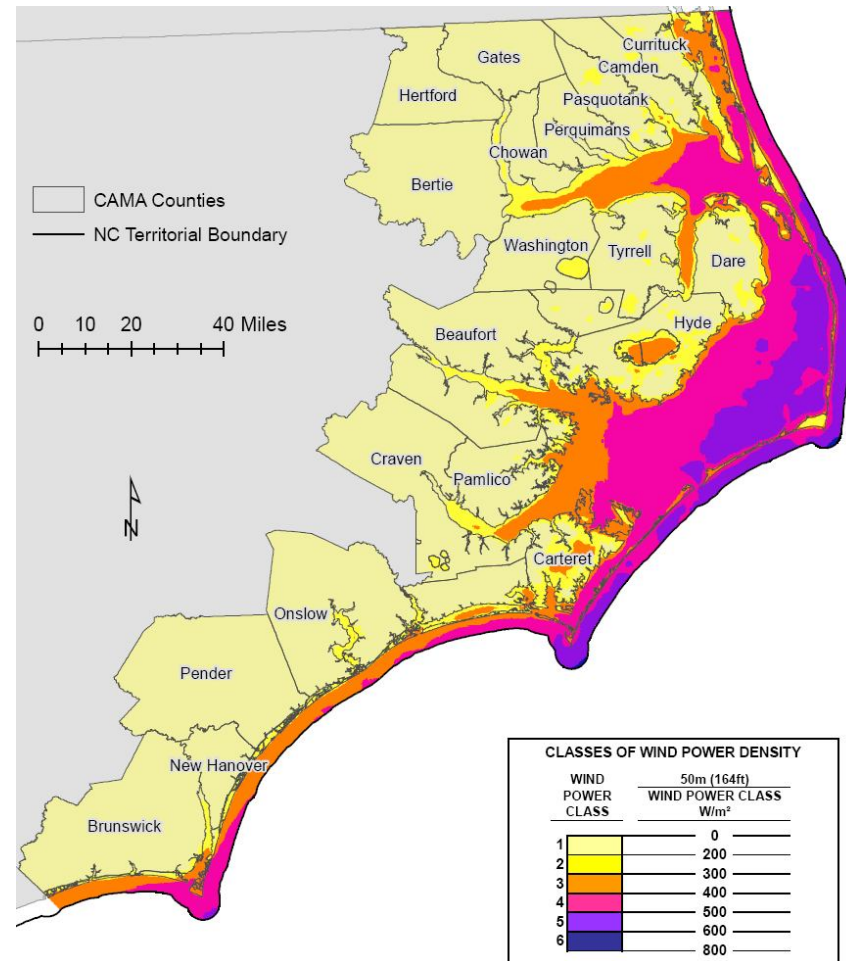
Coastal North Carolina

Opportunities

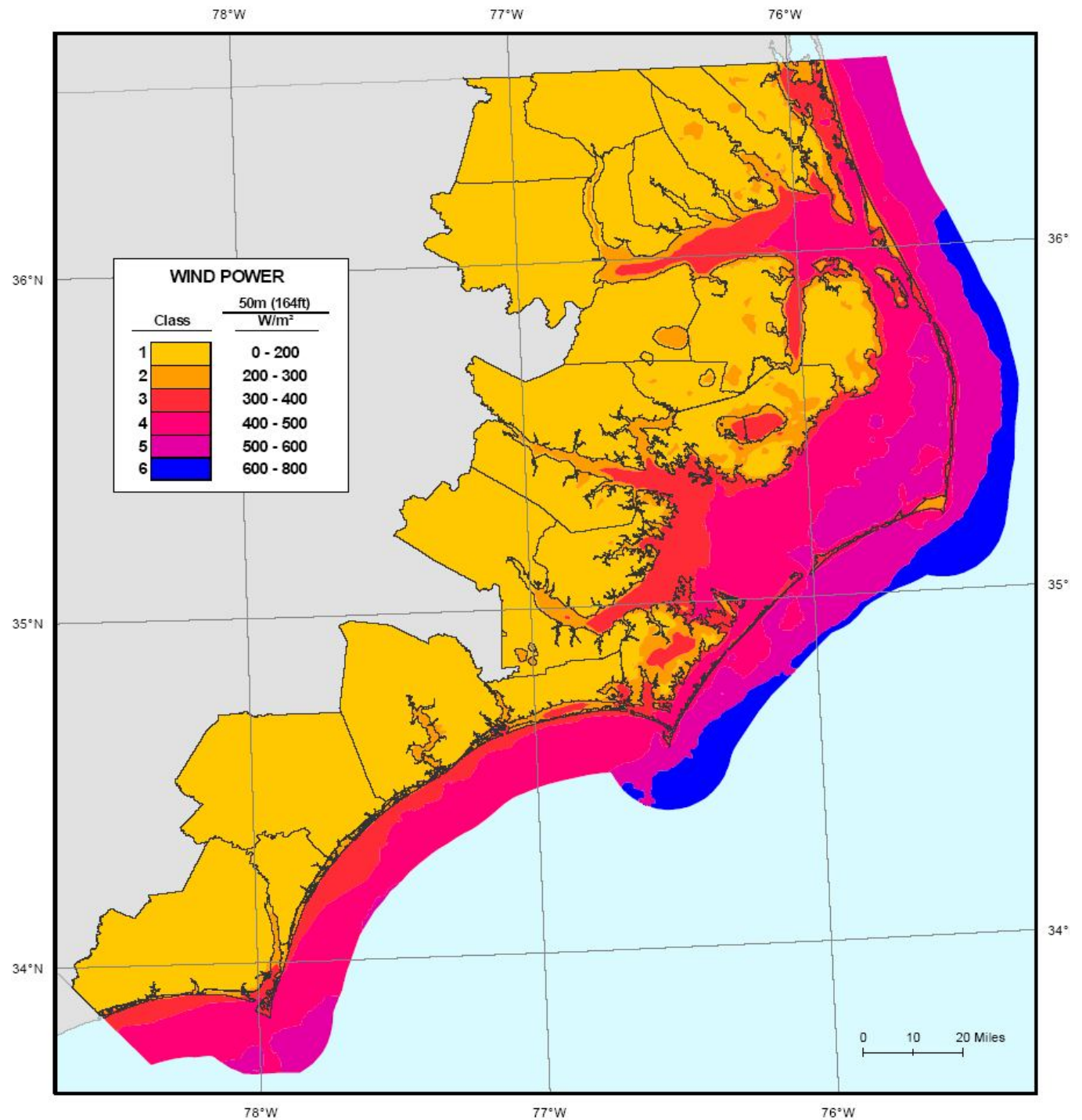
- Coastal NC has the land area and wind resource for large wind farms.
- The Pamlico and Albemarle Sounds hold the highest potential for wind energy in NC

Issues

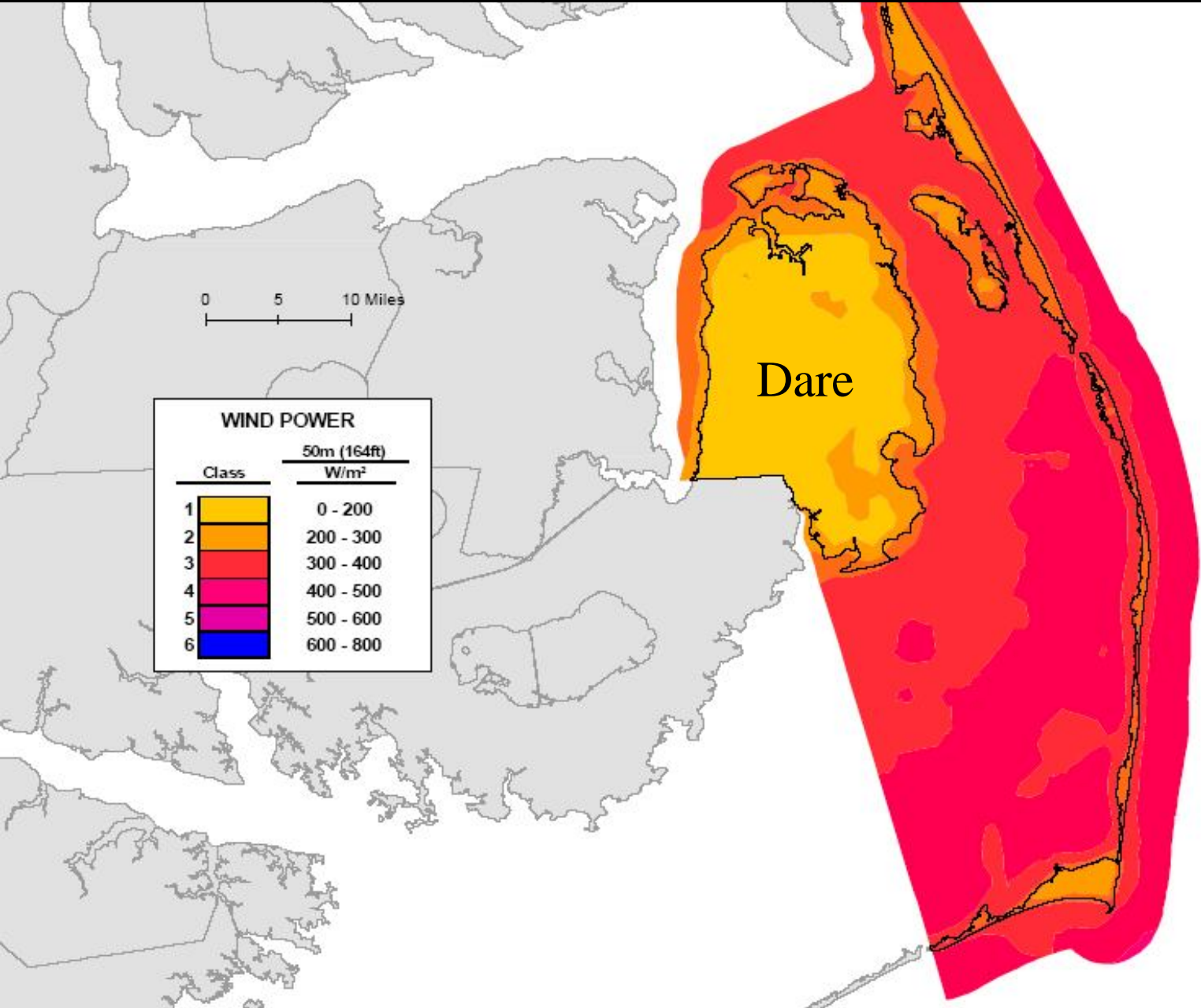
- Exclusion zones (sensitive habitat & military use zones)
- Transmission Capacity



Coastal Counties (All)

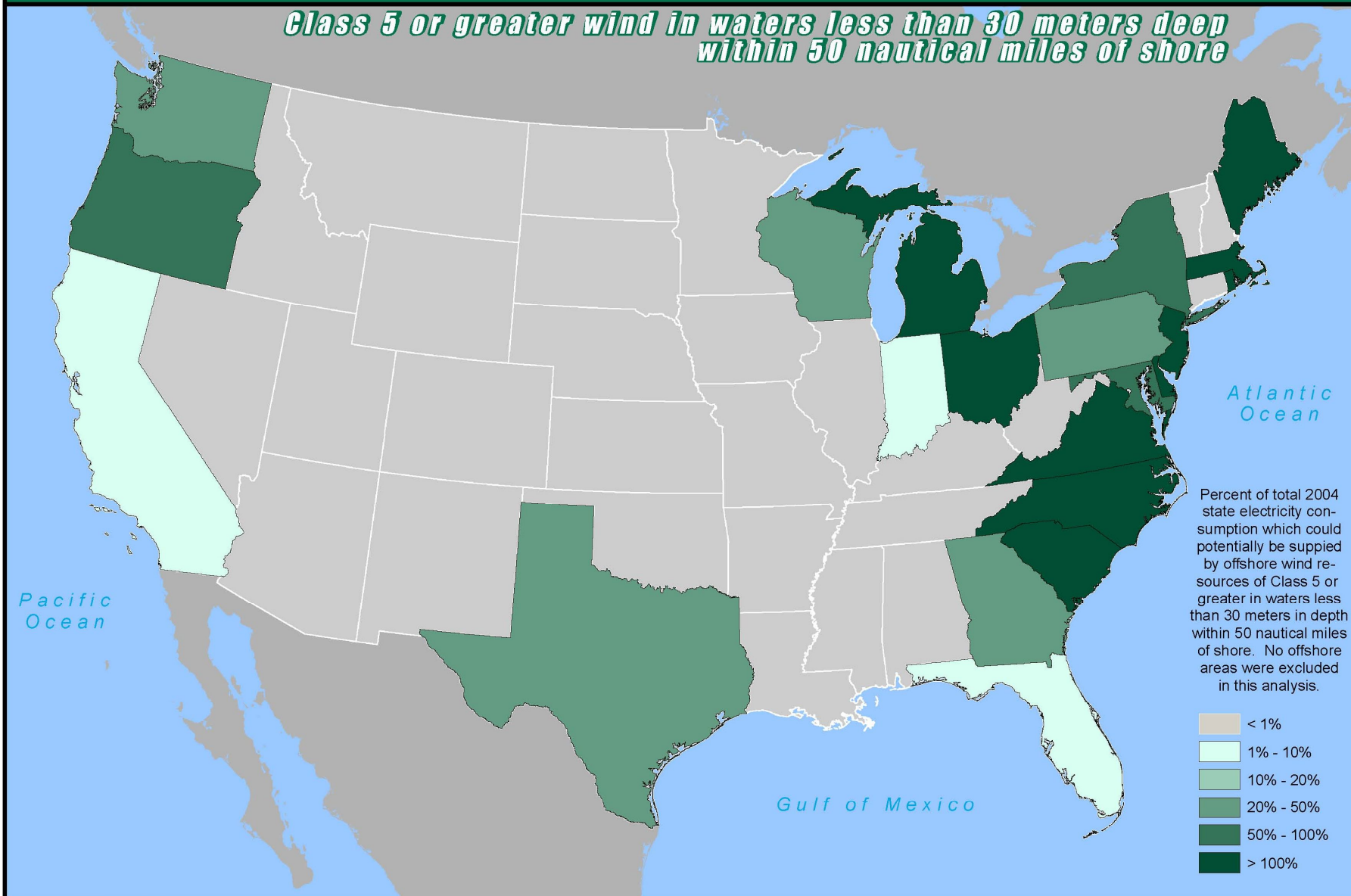


Counties	Wind Power 50m (ACRES)						
	Total	Class 1	Class 2	Class 3	Class 4	Class 5	Class 6
Dare	1058232.8155	823.65	12152.04	556885.60	282008.54	206362.98	0.00



Potential Electricity Supply from Shallow Offshore Wind by State

*Class 5 or greater wind in waters less than 30 meters deep
within 50 nautical miles of shore*



0 250 500 1,000
Kilometers
0 150 300 600
Miles

February 12, 2007
Data Source: 200702musial_osbystate_rev3.xls

Map produced by
U.S. Department of Energy
National Renewable Energy Laboratory



North Carolina Economic Impacts

from 1,000 MW of New Wind Development

Wind Energy's Economic "Ripple Effect"

Direct Impacts

Payments to Landowners:

- \$2.7 million/year

Local Property Tax Revenue:

- \$10.7 million/year

Construction Phase:

- 1,628 new jobs
- \$188.5 million to local economies

Operational Phase:

- 243 new long-term jobs
- \$21.2 million/year to local economies



Indirect and Induced Impacts

Construction Phase:

- 1,361 new jobs
- \$124.1 million to local economies

Operational Phase:

- 214 local jobs
- \$20.4 million/year to local economies

Totals

(construction + 20 years)

Total Economic Benefit:
\$1.1 billion

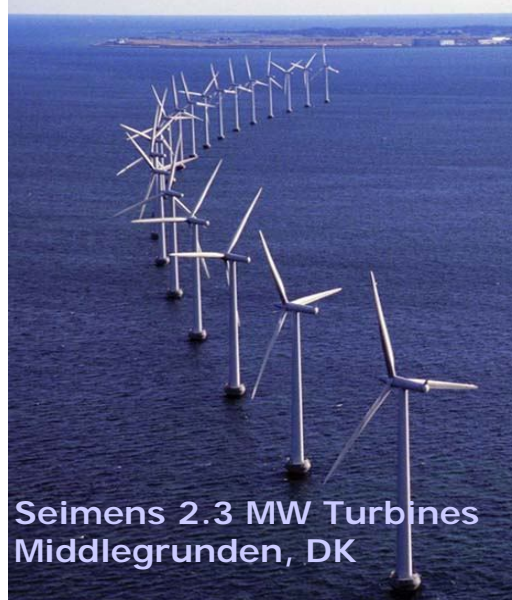
New Local Jobs During Construction: 2,989

New Local Long-term Jobs: 457

Source: NREL

Construction Phase = 1-2 years
Operational Phase = 20+ years

Offshore Technology Status



- ▶ Fixed bottom shallow water 0-30m depth
- ▶ 2 – 5 MW upwind configurations
- ▶ 70+ meter tower height on monopoles and gravity base
- ▶ Mature submarine power cable technology
- ▶ Existing oil and gas experience essential
- ▶ Costs are not well established in the US.

Source: NREL

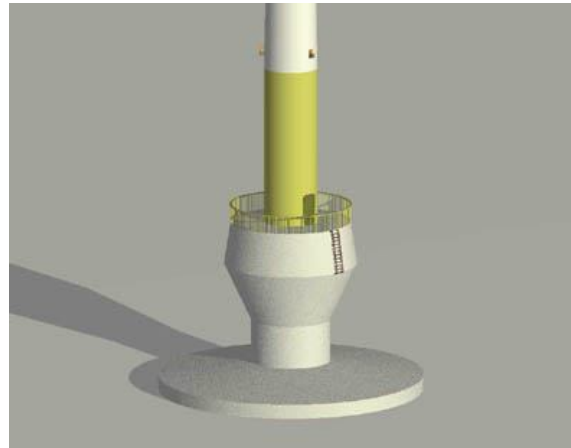
Shallow Water Foundation Types

Proven Shallow Water Designs



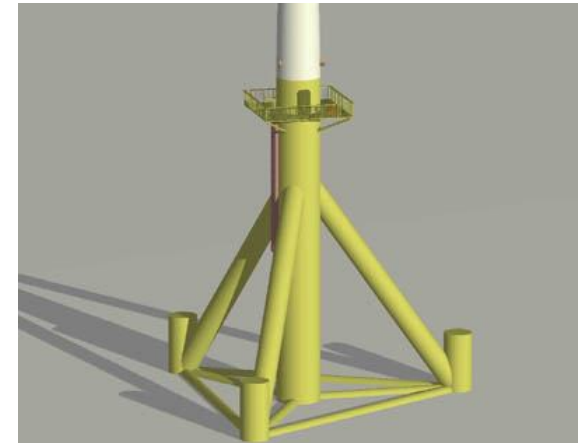
Monopile Foundation

- Most Common Type
- Minimal Footprint
- Depth Limit 25-m
- Low stiffness



Gravity Foundation

- Larger Footprint
- Depth Limit 20m
- Stiffer but heavy



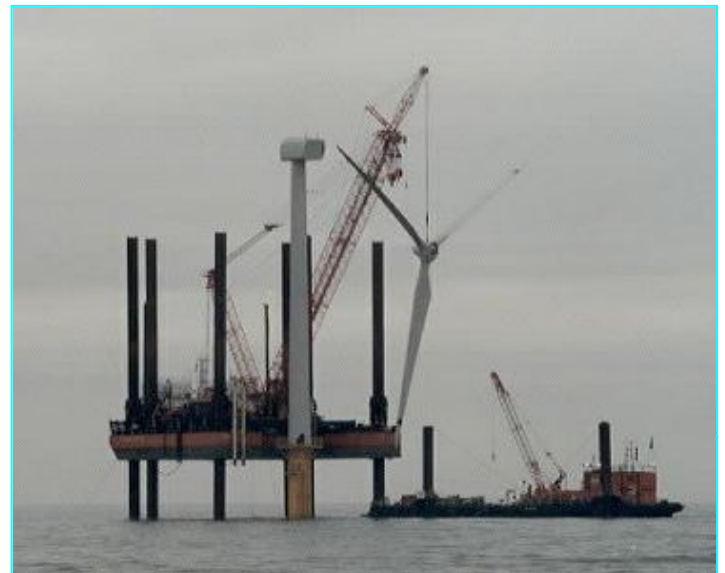
Tripod/Truss Foundation

- No wind experience
- Softer soils
- Oil and gas to 450-m
- Larger footprint

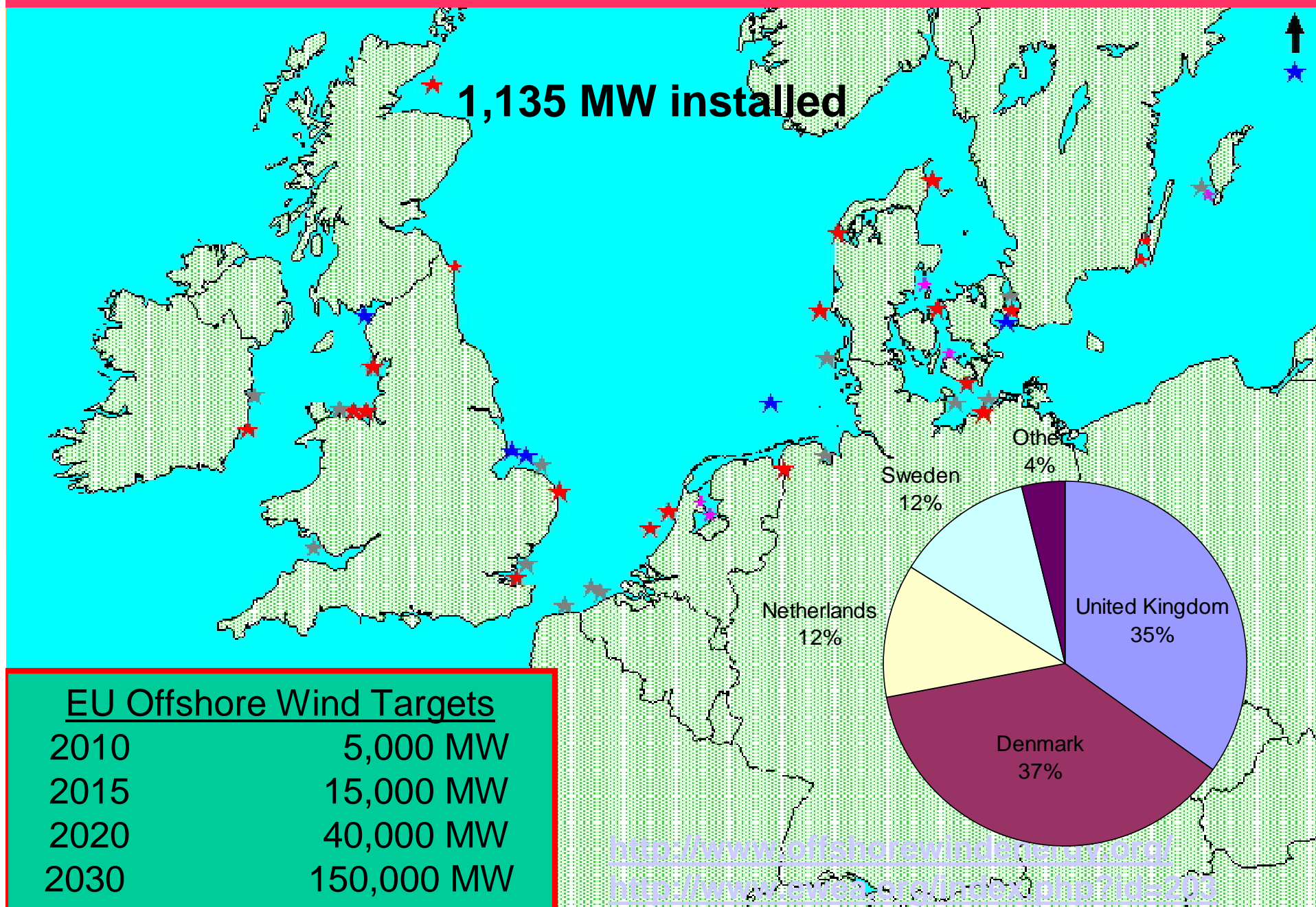
Graphics source: <http://www.offshorewindenergy.org/>

Offshore Wind Benefits

- ❑ Better wind resources
 - Less turbulence – steadier wind
 - Higher wind = better energy production
 - Higher capacity factors – load matching
- ❑ Less visual impacts than land-based
- ❑ Avoids land-based size limits
 - **Shipping** – Roadway limits
 - **Erection** – Crane limits
 - Larger machines are more economical.



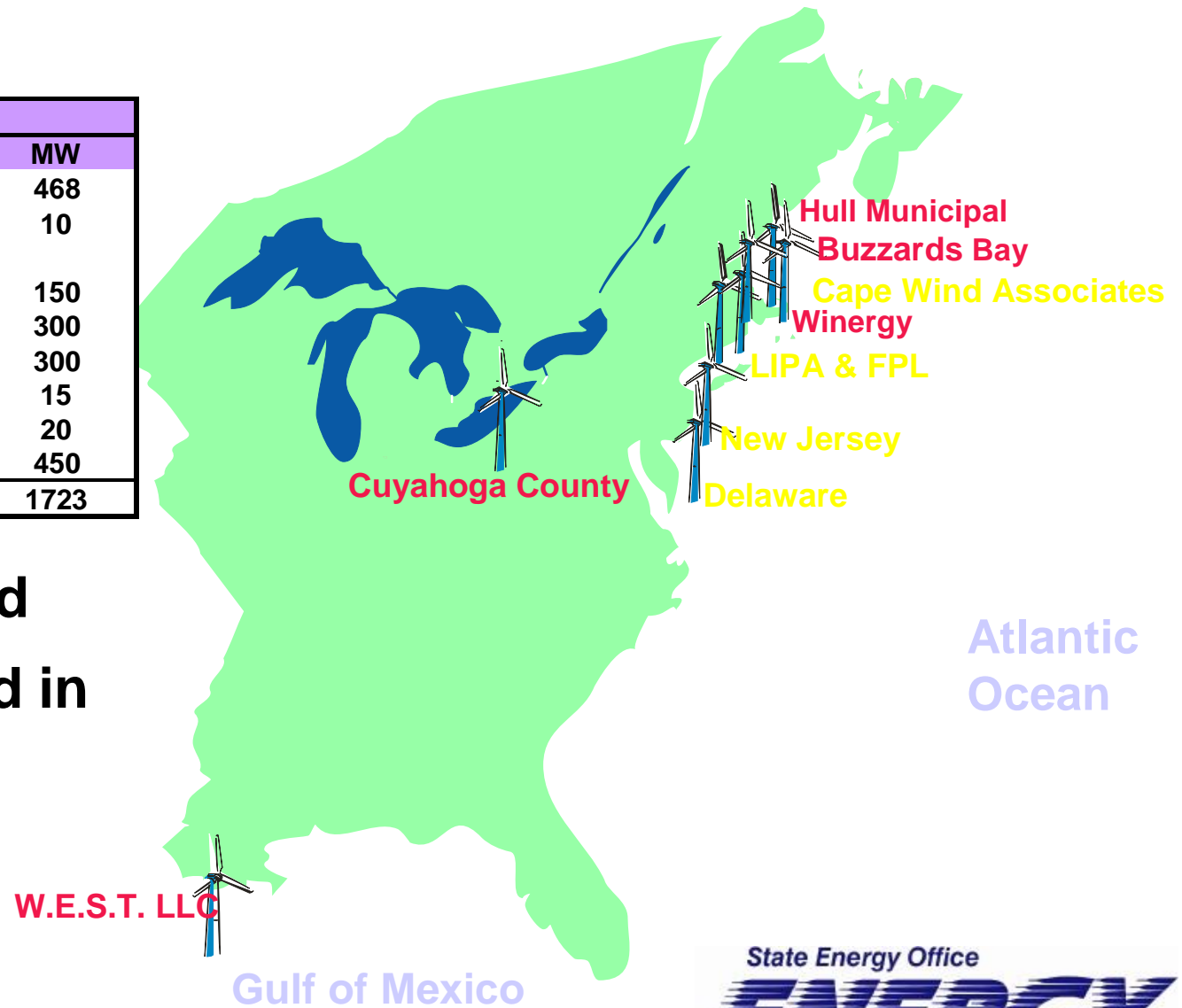
European Activity Offshore



US Projects Proposed

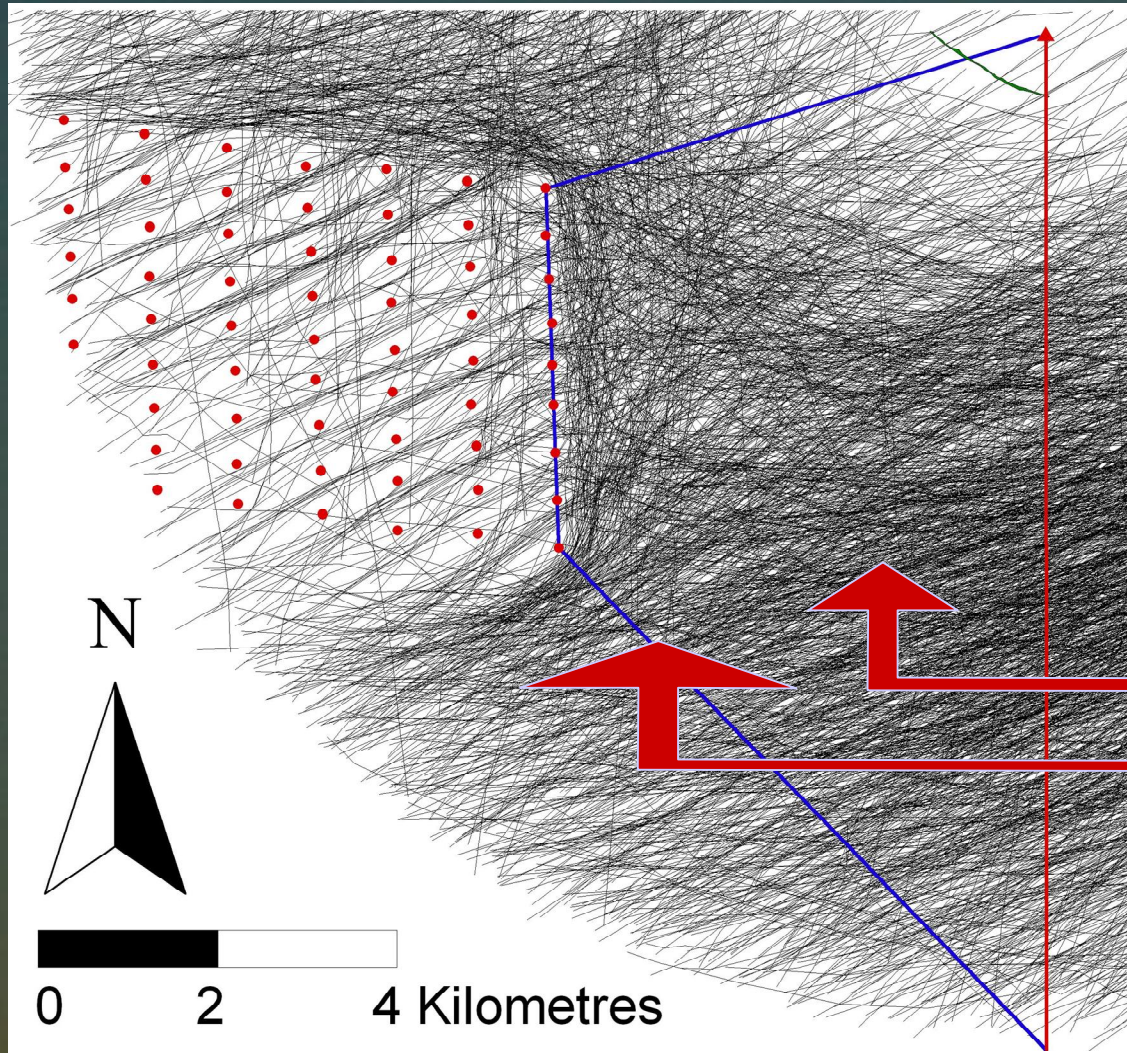
US Offshore Projects		
Project	State	MW
Capewind	MA	468
Winergy (plum Island)	NY	10
W.E.S.T.	TX	150
Buzzards Bay	MA	300
New Jersey	NJ	300
Hull Municipal	MA	15
Cuyahoga County	OH	20
Delmarva	DE	450
Total		1723

No Offshore wind
projects Installed in
U.S. - yet



Radar tracks of waterbird flocks at Nysted (Rødsand), Denmark, Autumn 2003. Also shown is the change in waterfowl tracks. (Credit: Danish National Environmental Research Institute [NERI]).

Nysted Migrating Birds



Operation (2003):

Response distance:

day = c. 3000m

night = c. 1000m

Mitigate Visual Effects



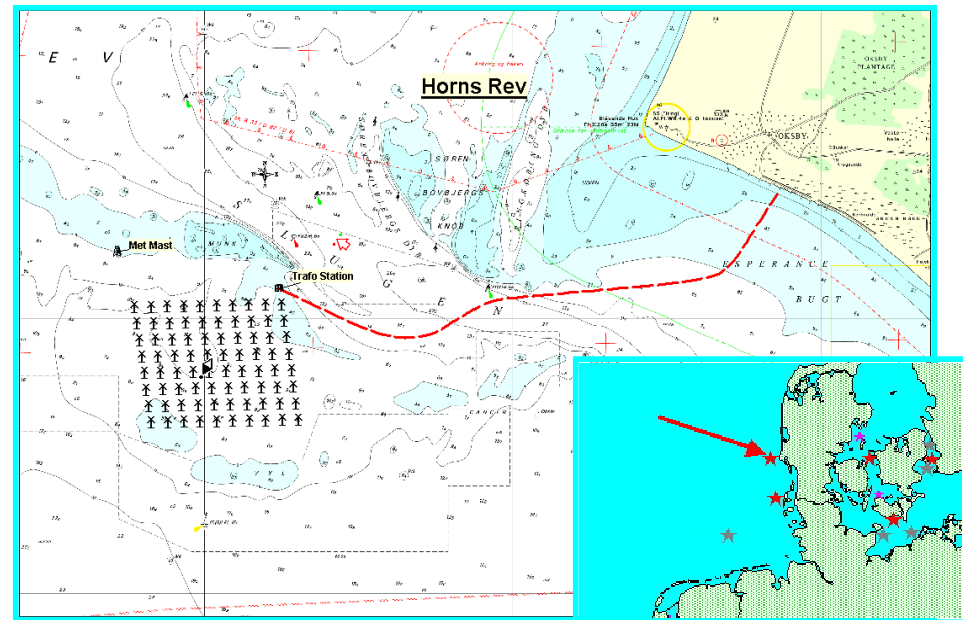
Pre-visualization of the Horns Rev wind farm from Blåvands Huk (above) and actual post-construction photograph from Blåvands Huk (below) (Credit: DONG Energy)



Horns Rev Wind Farm



Country: Denmark
Location: West Coast
Total Capacity: 160 MW
Number of Turbines: 80
Distance to Shore: 14-20 km
Depth: 6-12 m
Capital Costs: 270 million Euro
Manufacturer: Vestas
Total Capacity: 2 MW
Turbine-type: V80 - 80m diameter
Hub-height: 70-m
Mean Windspeed: 9.7 m/s
Annual Energy output: 600 GWh



Wind Power Benefits

- ▶ Renewable Energy - part of a diversified portfolio
- ▶ Economic
 - » **Cost competitive**
 - » **Land lease payments**
 - » **Local property tax** revenue
 - » Jobs creation during construction, and O&M
 - » Econ. diversification (a 2nd crop for farmers)
 - » Tourism and education opportunities
- ▶ NC Government Opportunities
 - » State Property Office owns sound bottoms
- ▶ Environmental Benefits
 - » No SO_x, NO_x, CO₂ particulates , or mercury
 - » No water!



NC Wind Permitting

- ▶ NC Legislature is considering
 - » Regulating 2 MW and larger project
 - » Designating offshore wind as “water dependent”
 - » Use CAMA as the coastal wind regulatory body

Project Review Areas

- ▶ Wildlife (birds, bats, endangered species)
- ▶ Aviation - obstruction and radar interference
- ▶ Visual Impact and shadow flicker
- ▶ Wetlands
- ▶ Noise
- ▶ Ocean/sound bottom lease arrangements
- ▶ Construction transportation access
- ▶ Radio wave interference (am/fm/tv/microwave)
- ▶ Cultural
- ▶ Plants
- ▶ Soils

Key Issues for Wind Power

- ▶ Federal production tax credit uncertainty
 - » now about 2.1 cents/kWh – extended to Dec 2012
- ▶ Siting and permitting: avian/bat impact, perceived noise/visual issues, military airspace
- ▶ Transmission: access, new lines
- ▶ Operational impacts: intermittency, battery storage
- ▶ Accounting for non-monetary value: green power, no fuel price risk, reduced emissions, carbon credits

=>



Horns Rev – Condensation Vapor Trails



Thank You

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1830 A Tillery Place
Raleigh, NC 27604
919-733-2230 or 800-662-7131
Bob Leker (SEO wind program manager) – 919-733-1907
www.energync.net

Wind information websites:

- ▶ NC Coastal Wind -
www.ncsc.ncsu.edu/programs/The_Coastal_Wind_Initiative.cfm
- ▶ American Wind Energy Association - www.awea.org
- ▶ U.S. DOE Wind Powering America -
<http://www.eere.energy.gov/windandhydro/windpoweringamerica>

Acknowledgement to the NC Solar Center and the National Renewable Energy Laboratory for many of the slides and images used in this presentation



Carteret County Opportunities

Land Based Example

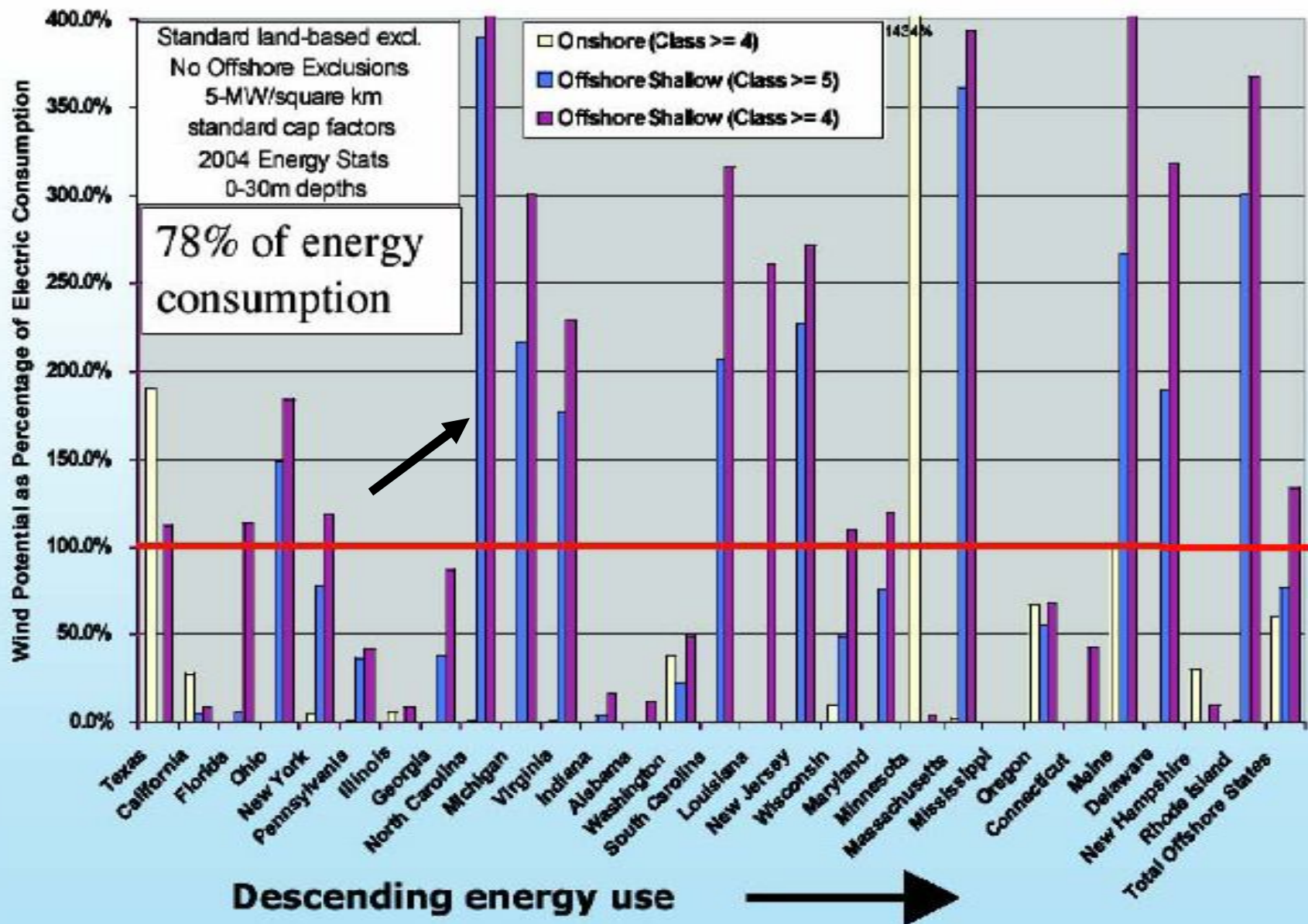
Large Areas of Class 3 Wind Resource



N. River Farms

- 4,500 acres (7 square miles)
- Development example:
 - 10% of farm area
 - 25 turbines (2MW each)
 - 50MW, power adequate for 11,250 homes.

28 Offshore States Wind Energy Potential



Offshore Turbines

– designed for offshore sites

- ▶ Foundation systems for underwater use
- ▶ Larger towers, bigger turbine gearboxes, larger blades
- ▶ Hardware designed for marine applications
- ▶ Turbines designed to run at the higher wind speeds found over water
- ▶ Designed for delivery and installation using barges

Offshore Wind Energy Cost Factors



↑ Upward Cost Pressures

- ↑ Turbine Supply Shortages
- ↑ Steel and copper price increases
- ↑ Regulatory Uncertainty
- ↑ Euro/\$ Currency Exchange Rates
- ↑ Risk Uncertainty (public acceptance, reliability issues, insurance, unstable incentives policy)

↓ Downward Cost Drivers

- Deployment
 - ↓ Learning Curve Effects
 - ↓ Mass production
 - ↓ Infrastructure development
- Technology Improvements
 - ↓ Land-based Innovations
 - ↓ High reliability components
 - ↓ Larger turbines

NC Wind Attitudes Public Survey

- systematic, proportional sampling of 404 eastern and 400 western NC households by ASU – 2004 report

Western NC

- ▶ By a margin of 2 to 1, respondents are OK with ridge top turbine placement.
- ▶ By a margin of 3 to 1, respondents would allow placing a turbine near existing towers.
- ▶ Greatest barrier is aesthetic and the potential negative effect on tourism/land values.

Eastern NC

- ▶ 7 out of 10 support turbines on coastal mainland, offshore, and with existing towers.
- ▶ Concerns about turbines placed in national forests.

NC Wind Activities

- 1) **Wind Resource Assessment**
 - Mapping, consultation, and feasibility studies
 - Anemometer loan programs
- 2) **Small Wind Demonstration Site – Beech Mtn.**
- 3) **Education**
 - Wind forums & presentations
 - Workshops run by ASU and the Solar Center
 - Wind conferences
- 4) **Recent development of Model Wind Ordinance**
- 5) **Legal/Permitting Issues**
- 6) **Attitudinal surveys**
 - Statistical surveys showing public support for wind power
- 7) **Web Sites:** <http://www.wind.appstate.edu/>
<http://www.ncsc.ncsu.edu/>



Small Wind Demo site
at Beech Mtn

Offshore Turbine Suppliers

Turbine Manufacturer	Turbine model & rated power	Date of availability	Offshore Operating Experience
Bard Engineering	VM - 5 MW	2008-09	Onshore prototype 2008
General Electric	GE – 3.6-MW	2003	Commercial inactive
Multibrid	M5000 - 5 MW	2005	Onshore 2005
Nordex	N90 - 2.5 MW	2006	Offshore Demo 2003
RePower Systems	5M - 5 MW	2005	Offshore Demo 2006
Siemens	SWT-2,3 - 2.3 MW	2003	Commercial
Siemens	SWT-3.6 - 3.6 MW	2005	Commercial
Vestas	V80 - 2 MW	2000	Commercial
Vestas	V90 - 3 MW	2004	Commercial

North Carolina – Economic Impacts

From the 20% Vision
(12,325 MW new Onshore and Offshore North Carolina development)

Wind energy's economic "ripple effect"

Direct Impacts

Payments to Landowners:

- \$5.028 million/year

Local Property Tax Revenue:

- \$20.182 million/year

Construction Phase:

- 29,021 new construction jobs
- \$3.362 B to local economies

Operational Phase:

- 6,636 new long-term jobs
- \$630.1 M/yr to local economies



Indirect & Induced Impacts

Construction Phase:

- 24,265 new jobs
- \$2.21 B to local economies

Operational Phase:

- 4151 local jobs
- \$394.5 M/yr to local economies

Totals

(construction + 20yrs)

Total economic benefit =
\$26.07 billion

New local jobs during
construction = 53,286

New local long-term jobs
= 10,787

JEDI: Jobs and Economic Development Impact -

NREL model using county-level economic inputs to measure direct and indirect economic impacts.

Developing wind power to meet 6.5% of NC's year 2015 energy needs:

Jobs:

- 5,533 direct/indirect jobs during construction years
- 1,169 annual operational jobs

Local Spending:

- over \$280 million in local spending from construction
- over \$30 million in indirect local income per year

State Government Benefits



- ▶ Yearly royalties of \$5,000 per MW of turbines sited on state-owned lands
 - » Especially significant in NC Sounds
- ▶ Possible help meeting federal air quality standards
 - » Including wind generation could reduce pollution totals in emissions calculations

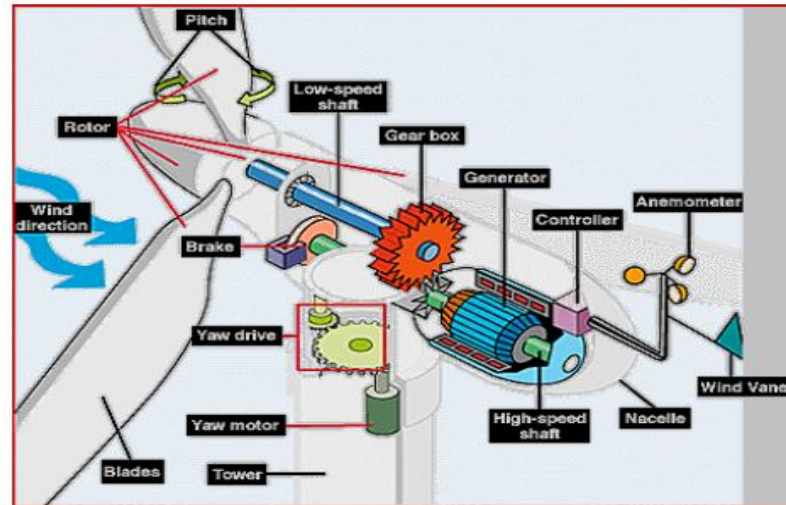


Wind Turbine Manufacturing

Assumption: 50,000 MW of national wind turbine development would lead to the following NC new jobs and investment potential based on current manufacturing activity that could support turbine parts production.

Employment - **4,600 new potential jobs:**

- ▶ Nacelle and controls (majority),
- ▶ Rotor,
- ▶ Gearbox and drive train,
- ▶ Generator and power electronics,
- ▶ Tower components.

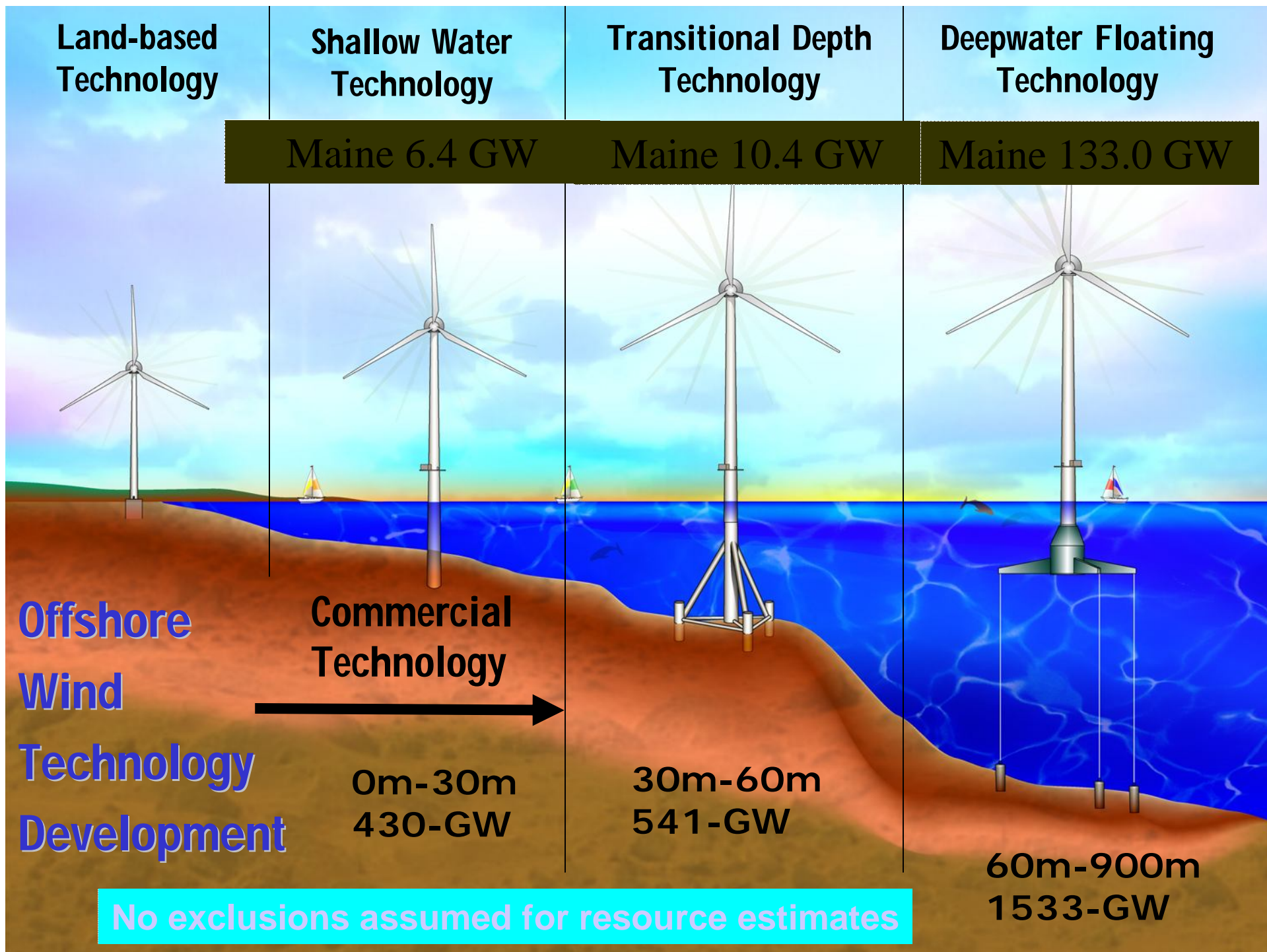


New Investment -
\$1.5 billion average investment
for each manufacturing opportunity noted above

Web report at

<http://www.repp.org/articles/static/1/binaries/WindLocator.pdf>





Preliminary Findings: Onshore

Onshore Wind Potential							
Counties	Wind Power 50m (ACRES)						
	Total	Class 1	Class 2	Class 3	Class 4	Class 5	Class 6
Beaufort	614849.4243	543323.00	53830.38	17696.04	0.00	0.00	0.00
Bertie	474778.3110	461859.29	12158.29	760.73	0.00	0.00	0.00
Brunswick	671853.4080	526841.07	25977.45	64695.01	47917.69	6422.19	0.00
Camden	196389.1779	146856.94	22054.45	12411.79	15065.99	0.00	0.00
Carteret	860710.2612	163616.87	131868.97	193251.91	304542.65	67429.87	0.00
Chowan	149777.9169	119963.49	24099.44	5714.98	0.00	0.00	0.00
Craven	495891.3098	465095.49	23509.02	7286.80	0.00	0.00	0.00
Currituck	337839.6078	100898.08	68726.22	96427.54	71228.31	559.45	0.00
Dare	1004326.6733	136695.25	76521.81	100671.82	375336.16	313897.53	1204.11
Gates	221799.3360	221799.34	0.00	0.00	0.00	0.00	0.00
Hertford	230991.3190	230763.83	227.49	0.00	0.00	0.00	0.00
Hyde	915073.0825	293291.45	134446.90	109888.62	257661.74	119784.38	0.00
New_Hanover	210134.4103	117713.35	20638.02	40580.39	30896.18	306.47	0.00
Onslow	582261.1269	478958.84	43138.39	50998.47	9165.42	0.00	0.00
Pamlico	363499.9744	198055.97	53526.83	102007.53	9909.64	0.00	0.00
Pasquotank	185925.4303	132508.29	31594.89	21662.98	159.26	0.00	0.00
Pender	597226.3285	552695.71	11614.63	32539.33	376.66	0.00	0.00
Perquimans	211233.0439	169288.67	16781.88	25162.50	0.00	0.00	0.00
Tyrrell	385690.6687	224030.17	48951.77	60318.68	52390.05	0.00	0.00
Washington	272326.5544	226636.92	28526.88	17162.75	0.00	0.00	0.00
TOTAL ACRES	8982577.3651	5510892.00	828193.73	959237.87	1174649.76	508399.90	1204.11
Percent of Total		61.35	9.22	10.68	13.08	5.66	0.01

TOP 5

1. Dare
2. Carteret
3. Hyde
4. Currituck
5. Brunswick

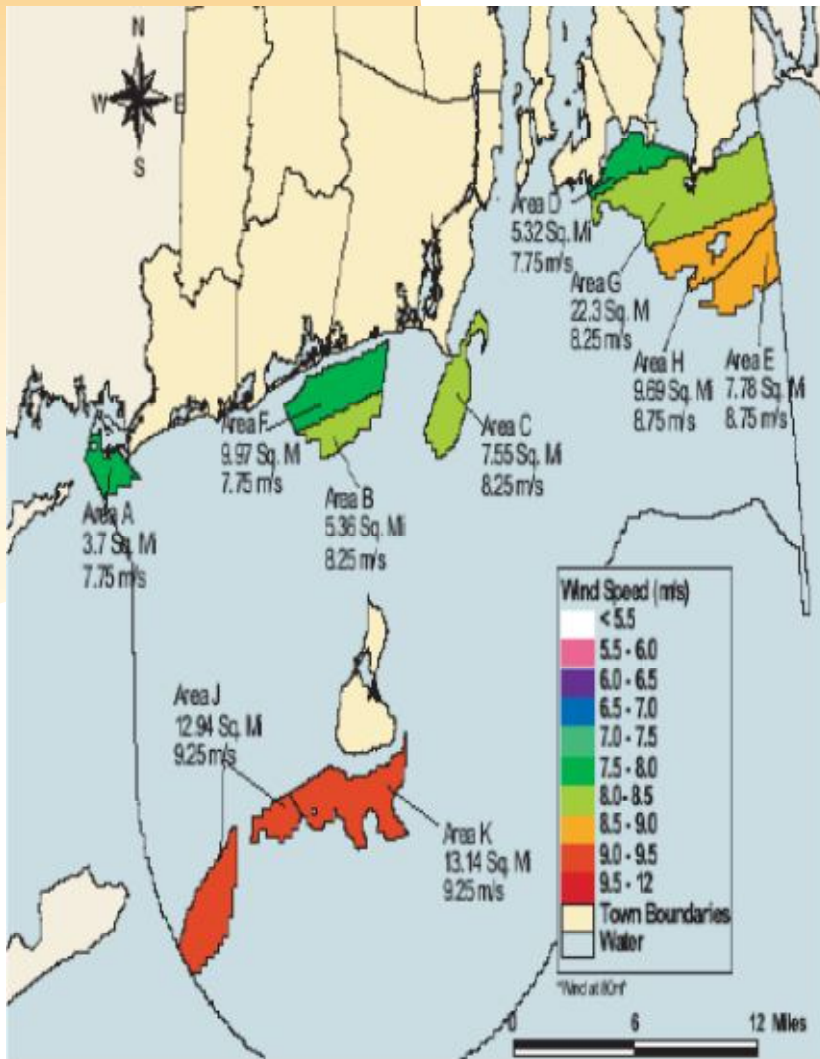
Preliminary Findings: Water-Based

Sound Waters Wind Potential							
Counties	Wind Power 50m (ACRES)						
	Total	Class 1	Class 2	Class 3	Class 4	Class 5	Class 6
Beaufort	81186.6827	19352.32	43932.03	17902.33	0.00	0.00	0.00
Bertie	21054.6860	8689.86	11609.72	755.10	0.00	0.00	0.00
Chowan	38917.3679	9664.80	23478.50	5774.06	0.00	0.00	0.00
Craven	32584.4292	10677.45	14582.60	7324.38	0.00	0.00	0.00
Camden	41815.5626	2517.80	11951.35	12202.26	15144.16	0.00	0.00
Washington	25997.8521	669.75	12464.03	12864.07	0.00	0.00	0.00
Pasquotank	40051.5774	3752.74	14585.00	21597.02	116.81	0.00	0.00
Perquimans	92422.0665	52568.81	14617.86	25235.39	0.00	0.00	0.00
Tyrrell	139446.6773	5178.54	17582.74	64346.49	52338.90	0.00	0.00
Hyde	444994.0298	4824.09	22457.44	71970.83	258946.69	86794.99	0.00
Currituck	116919.5711	1475.10	13786.50	72627.60	29030.36	0.00	0.00
Pamlico	142097.7145	7211.13	28927.35	98734.53	7224.70	0.00	0.00
Carteret	342101.1021	2850.38	35499.85	109640.79	192763.96	1346.13	0.00
Dare	1058232.8155	823.65	12152.04	556885.60	282008.54	206362.98	0.00
TOTAL ACRES	2617822.1347	130256.43	277627.01	1077860.47	837574.13	294504.10	0.00
Percent of Total		4.98	10.61	41.17	32.00	11.25	0.00

TOP 5

1. Dare
2. Hyde
3. Carteret
4. Tyrrell
5. Pamlico

Rhode Island Siting Study



Offshore Sites

- 10 Areas Identified
- Total of 98 Square Miles
- Over 6.6 MMWh/yr Wind Energy Potential

